an interval between school and college should be passed in an engineering works was not generally accepted. In the opinion of most speakers, it is better for a youth to go straight from school to a technical college for three years, and to obtain workshop experience after the college training, than to enter works at once. Dr. E. Hopkinson pointed out that for a boy to leave school at about the age of sixteen, and to enter a workshop with the idea of returning to school or college after an interval of two or three years involves a break in the scholastic course, and in habits of learning, which often has disastrous results. The best men are usually those who have had a continuous school and college career up to twenty-two or twenty-three years of age.

Another plan proposed is a combination of the half factory and half technical school, and this system is now under the consideration of the Manchester Association of Engineers. Mr. M. P. Higgins advocates the establishment of schools of this kind in an article in the August number of *Feilden's Magazine*. Such a school should, he says, possess the following features:—(1) a first-class commercially successful and productive machine-shop, which is a department coordinate in importance, influence and educational value with the academic department; (2) the pupils to be given instruction and practice in this shop during half the working hours in five days of each week, for a period of four years; (3) instruction in the public schools to be given during a portion of the other half of the time, equivalent to a high-school course, restricted, abridged and improved to meet the needs of these pupils; (4) special care and method of selection of pupils who have finished the grammar-school course and who have special aptitude for mechanical work; (5) management under a corporation whose trustees shall be practical business men.

If technical colleges were equipped with ordinary commercial apparatus and machines and kept in complete touch with engineering advances, much of the difficulty as to training would be removed, for students at such colleges would be able to combine the realities of the workshop with the theoretical instruction. But, as Dr. Nicolson pointed out in his paper, the data available in an engineering school are seldom of the latest, unless the teacher spends his summer in obtaining them. The instructor in electrical engineering has the special difficulty of the newness and constant development of his subject to contend with; but if he follows the practice of every year visiting the plants of the manufacturing companies and typical light and power stations, information is obtained which cannot be found in engineering literature and which has the highest value for educational purposes. The cultivation of close relations between the college and the practising profession should, indeed, be part of the duty of instructors and ought to be eagerly reciprocated by the working engineers as one of the surest ways of meeting foreign competition.

The closer sympathy between science and industry is, indeed, probably the most important factor to be considered. Engineers should see that technical colleges are brought into contact with current work, and arrangements might be made whereby young men from works could be sent from works to the laboratories of scientific institutions to carry on researches for the benefit of the firms employing them. This system is already partly in vogue in Germany and America, and has produced very gratifying results.

This summary of opinion may appropriately be concluded with some extracts from an article on the engineer of the twentieth century, by Prof. V. C. Alderson, Dean of the Armour Institute of Technology, Chicago.

"In the realm of mathematics the training of the engineer will be most rigid and exact. He will cut loose from the idealistic, academic mathematics, as the student of higher literature will cut loose from mere grammars. His mathematics must run down through his fingers, as it were. Mere juggling with symbols will be useless to him. He must regard his mathematics as one of his tools, as a means to an end, or as a language in which to express his thoughts. The future engineer may be successful if his training has included a greater or less amount of shop practice with perhaps indifferent laboratory instruction and a meagre equipment, but no engineer can be broadly successful and thoroughly competent without a deep and exhaustive theoretical treatment of engineering subjects. This does away with the common opinion that literature and books are not essential to the engineer's success, for the next quarter of a century will see the engineering profession rise to the dignity of the older professions.

"The conditions which will beset the engineer of the twentieth century will be exacting beyond anything we now know. The importance of a strong foundation in scientific principles cannot be over-estimated, for scientific principles are only the laws of nature. These principles cannot be learned readily after a man has begun his life work. His whole energy will then be devoted to applying these principles correctly, not in acquiring them laboriously. It will be a prime necessity for the technical college of the future to lay these foundations broad and deep. It will be regarded as a weakness for a college to teach its students only the knacks of the profession, only just enough to be an ordinary draughtsman, a tolerable surveyor, or first-class linesman.

"The technical graduate of the twentieth century will be marked by certain characteristics which are too rarely found in men trained in the colleges of literature and arts. Among these are directness of purpose, intellectual accuracy and clear thinking. The student of science and technology is trained in the realm of realities, where to commit error, to act without purpose, or to think vaguely are seen at once to be fruitful of harm. Economic and industrial needs will bring education from the cloistered lecture-room into the open air of the laboratory. Technical education will have a practical, helpful bearing upon the problems of life. No longer will the seclusion of the scholar be a mark of honour. Education will be found at the bench, by the forge, in the shop, the laboratory and the drafting-room, as well as in the library. The lesson to be taught will be how to apply scientific ideas to the solution of problems actually arising in the struggle to bring the forces of nature under the sway of man.

"As technical education develops, questions of far-reaching importance must be settled. Probably the most important will be the decision as to what kind of man shall guide the technical college. In law, medical and theological schools, the lawyer, the doctor and the minister, respectively, hold first place and have much to say both in the actual training and in the management of the schools. Prominent members of the profession direct the destinies of the schools. To a much less extent do practising engineers influence the technical schools.

"The engineering college represents that form of scientific education most suitable to the exacting demands of advancing civilisation. The particular form of education which it gives through shop and laboratory practice, through practical tests, through acquaintance with the needs of industry, must not and will not be retarded by the classic heirlooms of the literary college. The engineering college must fill its own niche and work out its own salvation. Technical education is an educational and not an engineering problem.

"The technical college in which the future engineer is to be trained has several important characteristics to maintain. First, to educate scientifically and technically those who shall lead the march of the coming civilisation in industrial lines; second, to educate the public to a true sense of the value of applying scientific principles to industrial processes; third, as the university has for one of its functions the extension of human knowledge in any and all lines, so the technical colleges will recognise that the investigation of questions relating to applied science is within its own sphere of usefulness. Probably no investigation to-day would be more fruitful of good results to the engineering profession and to the public at large than the systematic study and thorough test of materials of construction. Such an investigation done on a large scale, on specimens of full building size, in a scientific manner, would save millions of dollars and put the science of construction on a scientific and economic basis. While the university asks no questions about the usefulness of the information gathered within its walls, the technical college must make its investigations in fields that are distinctly useful."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LORD AVEBURY referred to the neglect of scientific education in secondary schools, in an address delivered at Nottingham on Tuesday, before the Association of Chambers of Commerce of the United Kingdom. He pointed out that the public schools are legally bound, by the regulations made by Lord Salisbury's Royal Commission, to give in all examinations one-eighth of the marks for mathematics, one-eighth for modern languages, and one-eighth for science. How science fares may

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be judged by the fact that one public school with 900 boys has four science masters, and another with 500 boys only has three. In fact, the complaint made long ago by Ascham and Milton, and reiterated by Royal Commission after Royal Commission, still holds good to a great extent.

THE following list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science), 1901, has been issued by the Board of Education, South Kensington:—*Royal Exhibitions.*—Walter Smith, Henry F. C. Walsworth, Alec J. Simpson, James C. Smail, John Good, Sydney F. Paul, George E. Piper. *National Scholarships for Mechanics.*—George W. Phillips, Alfred W. Steed, David P. Grubb, Thomas G. John, Henry J. Jones. *Free Studentships for Mechanics.*—Herbert G. Tisdall, Thomas Chester. *National Scholarships for Physics.*—George W. Andrew, Leonard Southerns, John B. Homer, Sydney H. Higgins, Roger E. Grime. *Free Studentship for Physics.*—Otmar U. Seeman. *National Scholarships for Chemistry.*—Herbert B. P. Humphries, Alfred Shepherd, Alfred Berry, Donald Levy, Sydney H. Smith. *Free Studentships for Chemistry.*—Joseph A. Stokes, John F. Stansfield. *National Scholarships for Biology.*—Arthur R. Mynott, Alfred Eastwood, Richard C. Bristow, Malcolm Wilson. *Free Studentship for Biology.*—Florence E. Pratt. *National Scholarships for Geology.*—John E. Haworth, Claude G. Sara, Tobias Clegg.

THE candidates successful in the recent competition for the Whitworth Scholarships and Exhibitions are announced by the Board of Education, South Kensington, to be as follows:—Scholarships, 125*l.* a year each (tenable for three years)—Charles E. Handy, John E. Jagger, Albert Wilson, James C. Macfarlane. Exhibitions, 50*l.* (tenable for one year):—Thomas P. Shilston, Arthur Baker, George W. Phillips, George H. Andrews, John S. Nicholson, Henry F. C. Walsworth, Thomas G. John, Harry J. Wickham, John Good, James C. Smail, Gilmour E. Brown, George E. Piper, Alexander Gray, Arthur H. Sturdee, Harry Topham, Reginald Lavender, William H. Snow, Richard F. Barber, Harold Scragg, Harold E. Morrow, Thornton Knowles, John Ingham, Percy M. Bennett, Ernest G. Beck, Alfred G. Fox, Harold Fowler, Frank Lord, Thomas Chester, William E. Gardner, Roland W. Parry.

FROM particulars given in the thirteenth annual report just published by the National Association for the Promotion of Technical and Secondary Education, it appears that considerably over a quarter of a million of money (or 286,980*l.*) has become involved during the past year for the structural development of technical schools in England. If this sum be added to the trustworthy estimate of 2,643,172*l.* given in last year's report, it shows that the total amount incurred in England (excluding London) for 295 schools under municipal and public bodies is now at least 2,930,152*l.*; if all outlays upon other schools could be definitely assessed, this sum would doubtless reach more than 3,000,000*l.* (excluding London). The largest of the new building schemes is that of Bolton, the estimated capital outlay being 80,000*l.* The school will be established to a considerable degree upon Continental models, and will form one of the most important centres of technological training in the country. In Liverpool, 14,500*l.* is to be utilised for the equipment of a central technical school costing over 100,000*l.*; an important movement towards centralisation is consequently now taking place in that city.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 26.—M. Bouquet de la Grye in the chair.—Remarks by M. Janssen upon some observations of the Perseids from the Observatory at the summit of Mont Blanc.—On the application of the principle of energy to electrodynamic and electromagnetic phenomena, by M. E. Sarrau.—Critical remarks concerning the determination of sex in the Lepidoptera, by M. Alfred Giard. In discussing the results of the experiments of M. C. Flammarion upon the influence of colours in the production of the sexes in *Sericara mori*, the author points out certain morphological data which modify the interpretation of the experiments considerably. In the opinion of the author, the great error of physiologists in studying questions of this order, as in many others, is in completely neglecting the morphological data, and in considering the animal or vegetable egg as a point of absolute departure, instead of a complex of energies accumulated by the varied conditions of existence or found in the ancestral organism.—On the mode of action of the brakes of automobiles, by M. A. Petot. From the formulæ usually employed to express the relation between the inertia and the co-efficient of adherence it can be deduced that it ought to be impossible to stop an electric tramway as rapidly as another vehicle, under similar conditions of speed and adherence. It is shown in the present note that this is an error, due to an inexact interpretation of the function of adherence during the application of the brake.—On the constitution of white light, by M. O. M. Corbino. According to M. Gouy, the different rays constituting the spectrum of white light are sinusoidal and perfectly regular components of one single complex vibration of any form whatever, and hence it follows that these components, their amplitude and phase remaining invariable, can interfere. According to M. Carvallo, the radiations separated by a grating are independent and consequently cannot interfere with each other. According to the author, the production of a system of mobile fringes in a channeled spectrum affords a crucial test of these two views. From these it is concluded that two radiations taken from different points of a continuous spectrum produced by white light are completely independent, and that in consequence it is impossible to consider them as two sinusoidal components of a single complex vibration.—The sexual elements and copulation in Stylorhynchus, by M. Louis Léger.—On a bacterial disease of the potato, by M. G. Delacroix. The disease in question, which is very prevalent in the centre and west of France, is due to a bacterium which appears to be identical with the *Bacillus Solanacearum* of E. F. Smith. It possesses the same characteristics on cultivation, and the symptoms of the disease observed in the United States on potatoes and tomatoes are similar to those observed in France. The only suggestion that can be put forward as a remedy is a triennial variation in the crops in order to clean the soil, which appears to be the vehicle of the disease, from the pathogenic organisms which it contains.—The invasion of streams of water in the department of Herault by *Jussiaea grandiflora*, and on the growth of this species in France, by M. P. Carles. The growth of this plant in some districts is so great that it forms true aquatic prairies. It has been stated that this plant could not fructify in France, but this is now shown to be inaccurate, since in the month of September on the River Orb the fruit was formed in the shape of capsules about 29 mm. in length, each capsule having five divisions containing about fifteen seeds. It is by these seeds that it multiplies so abundantly.

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